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Geological Survey

Museum Bulletin No. 8

GEOLOGICAL SERIES, No. 22 DECEMBER 28, 1914

THE HURONIAN FORMATIONS OF TIMISKAMING REGION, CANADA

by

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OTTAWA
GOVERNMENT PRINTING BUREAU
1914

No. 1483

December 28, 1914

Canada
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Museum Bulletin No. 8.
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INTRODUCTION.

In a paper[1] presented last year before that section of the International Geological Congress which dealt with the classification of Pre-Cambrian formations, attention was directed to the fact that only a fringe along the south of the Canadian shield, or great Pre-Cambrian province of North America, is well enough known to have an important bearing upon any general classification of the rock formations in that province. It was also pointed out that, so far as any such classification is concerned, this southern fringe is divided into three subprovinces by wide intervals either of unknown country or of granite and other formations that are of little utility for purposes of geological correlation. To visualize this idea more effectually the index map used to depict these regions is reproduced in Figure 1 of this paper. Before formations in adjacent regions can be reliably compared, it was held, the geological sequence in each should be fairly completely established by studying and comparing typical, or key districts. Local names were advocated

[1] Collins, W. H., A classification of the Pre-Cambrian formations in the region east of Lake Superior, Compte Rendu, XIIe Congrès Géologique International.

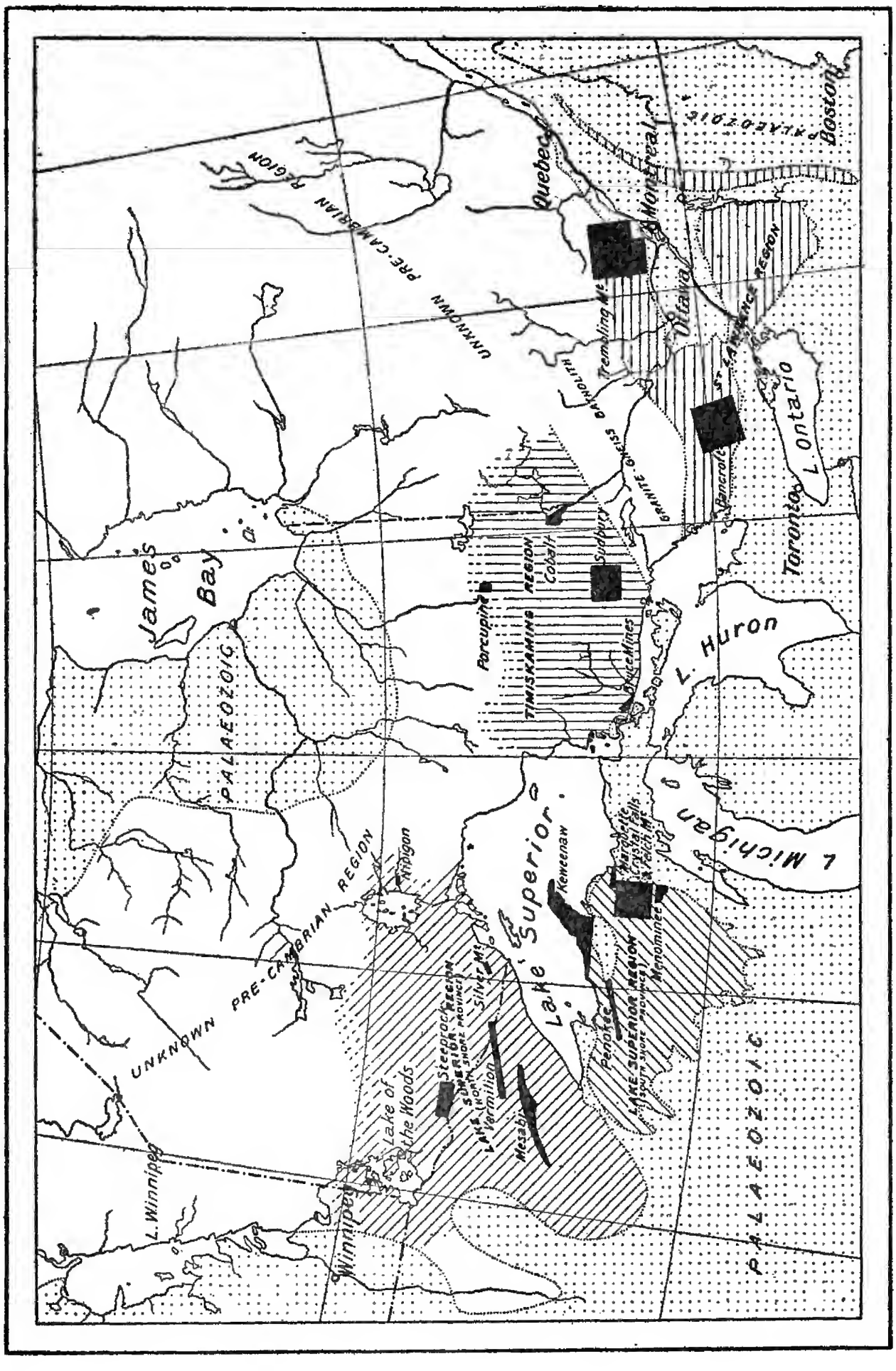


Figure 1. Diagram showing regions (in shaded lines) and districts (black) in which the geological nomenclature of the Pre-Cambrian shield has originated.

for formations and series of formations and it was suggested that grouping of these units into larger divisions should proceed as a conservative expression of the broader historical facts that would emerge from the accumulating data. A classification of the rocks of Timiskaming region embodying what was then known was presented, and the hope entertained that, while this classification would no doubt be expanded from time to time as new facts were obtained, such additions might be made with a minimum amount of alteration in the existing part of it.

The substance of that paper is repeated at some length because the present one deals with the same subject. It is, in fact, one of those anticipated supplementary contributions to the classification of the Pre-Cambrian rocks in Timiskaming region.

Thorough geological field work in Timiskaming region has been done, to a large extent, wherever economic developments have made such work necessary, and as these localities were commonly far apart special nomenclatures were adopted, in consequence of which the nomenclature for the whole region has become rather complicated. Fortunately most of the formation names now in use were first employed in only three localities, the Original Huronian, Sudbury and Cobalt districts, shown in Figures 1 and 2. Logan and Murray examined the Original Huronian area near Sault Ste. Marie between 1847 and 1858 and gave the names Laurentian and Huronian to the rocks found there. Later, the Huronian was subdivided into Lower Huronian and Upper Huronian. Coleman has studied Sudbury district since 1902, and, as that district is over 100 miles east of the Original Huronian and contains a considerably different assemblage of rocks, he found it expedient to use many new names, such as Sudbury series, Ramsay Lake conglomerate, etc., instead of, or in addition to, those used by Logan. Miller, likewise, has studied Cobalt district since 1903 and for similar reasons adopted a third group of names, including Cobalt series, Timiskaming series, etc. These different terminologies, created to meet the exigencies of geological exploration, have been used in neighbouring districts and given more or less widespread and confusing currency. One of the first steps, therefore, to be taken in composing a general classification of the Pre-Cambrian

formations in Timiskaming region is to connect these three districts by study of the intervening areas, to determine thereby the equivalences of the three systems of names, and to select from them a single system that will serve for the whole region.

The interval between Cobalt and Sudbury districts was covered in 1913 and the correlation thus made possible was given in the paper already referred to. During the summer of 1914 an effort was made to correlate Cobalt and Sudbury districts with the Original Huronian district, the results of which are set forth in this paper. All this work has been done in accordance with instructions from the Geological Survey. Estimates of thicknesses given in this paper are based upon measurements made in the field, but, since indirect methods of measurement had to be used in most cases owing to the low relief of the country, the results are not to be regarded as exact.

GEOLOGICAL DESCRIPTIONS OF AREAS.

The whole interval of 125 miles between Sudbury and the best known part of the Original Huronian district could not be examined in one season, so a chain of five smaller areas, spaced at such intervals across this distance that comparison of the formations in one with those in the next could be reliably made, was selected for study. The relative positions of the areas are shown in Figure 2. In order from west to east they are named the Bruce, Blind River, Whiskey Lake, Espanola, and Round Lake areas. The unexplored intervals between Bruce, Blind River, and Whiskey Lake areas are only 10 and 15 miles respectively and correlation across them was accomplished easily. A gap of 27 miles separates Whiskey Lake and Espanola areas, but this was partly bridged by incidental geological observations along the Canadian Pacific railway. Likewise the gap of 24 miles between Espanola and Round Lake areas was filled in by a study of the shore geology of Penage lake.

A brief summary of the geology of each of these areas is given below and the geological sequence and principal structural features of each are represented graphically in Figure 3.

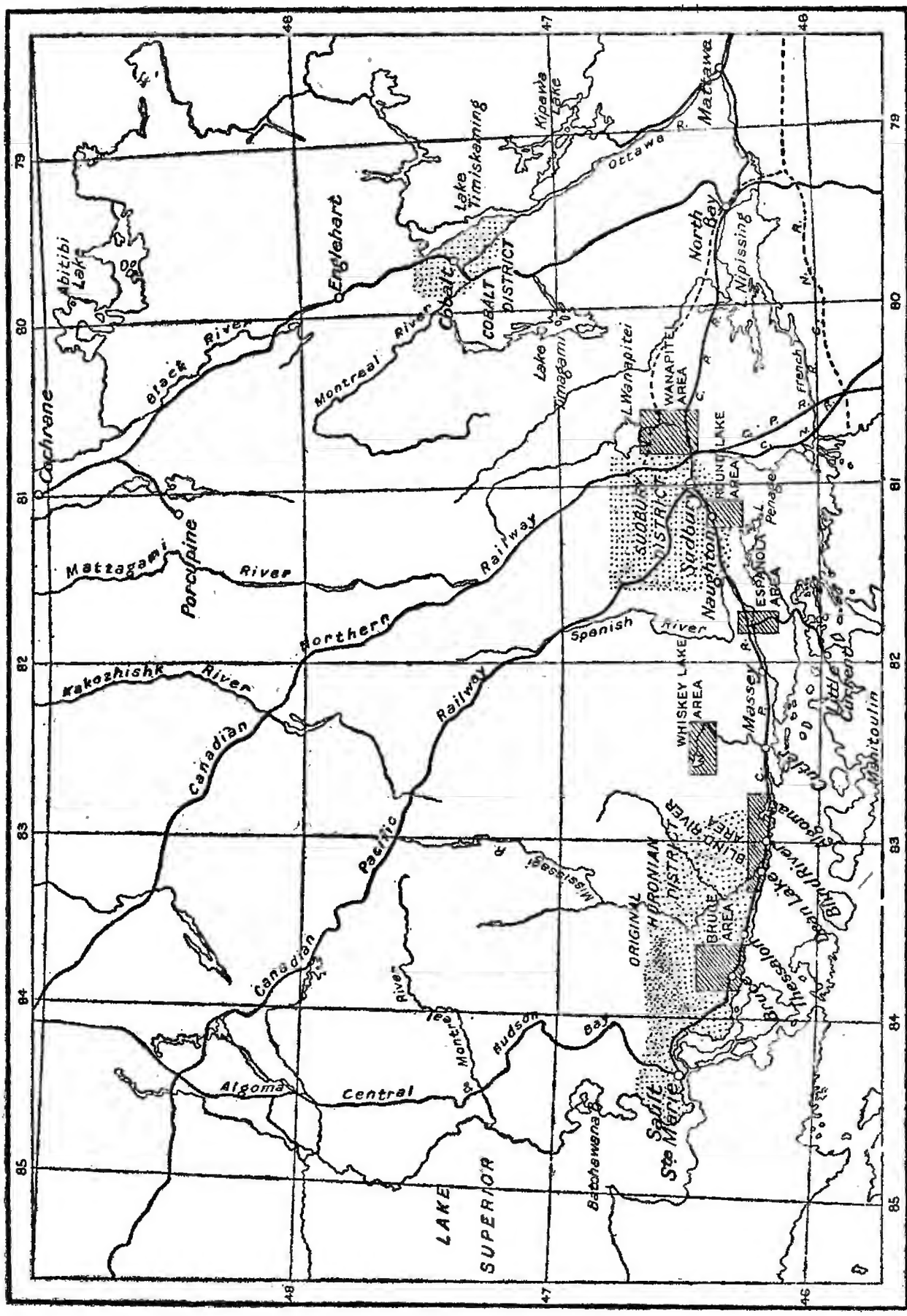


Figure 2. Index showing positions of the areas referred to in the text.

Bruce Area.

A complex of hornblende-schist, schistose amygdaloidal lava, and other basic igneous materials, exposed near Thessalon, constitute the oldest rock group in this area. It is intruded by granite-gneiss belonging to a batholithic mass that extends far to the east along Lake Huron. These schists and granite-gneiss form a crystalline basement upon which reposes, in conspicuous unconformity, a mantle of conglomerate, quartzite, greywacke, and limestone 12,000 feet thick. The sedimentary mantle is the Huronian of Logan, and the crystalline basement may conveniently be called the pre-Huronian. The Huronian sediments are separated by an unconformity into a lower and an upper series. They have been folded into a synclinal trough extending from northwest to southeast. The sides of this trough dip 50 degrees or less and have been relatively displaced about 5,000 feet vertically by a great fault that extends along the bottom of the trough. Huronian and pre-Huronian rocks are intruded by dykes and sill-like masses of diabase and the diabase is itself cut by small dykes of olivine-diabase, the youngest rock in the area.

Undisturbed contacts between the base of the Huronian sediments and the underlying crystalline rocks do not occur within the area mapped, but are found just outside it, on some small islands in Lake Huron, 3 miles east of Thessalon. There, a basal conglomerate rests upon older, decomposed granite-gneiss and schist. Van Hise and Leith have described the contact of this conglomerate with the underlying rocks as follows: "Resting upon this complex" (granite, gneiss and included schist) "was found a great bowlder conglomerate which differs radically in character from the pseudo-conglomerates of the Laurentian. The pebbles and bowlders instead of being widely separated are packed closely together. Within a very small area, a square yard or square rod, may be found all varieties of the material occurring within the Basement Complex—that is, many phases of crystalline schist, gneiss, granite, and granite gneiss. On one of the islands in which the contact was seen the line of separation is perfectly sharp and irregular, bending at one place at

an angle of 50°. Also the foliation of the granite gneisses abuts almost at right angles against the line of contact at one place. The contact here, then, has all the characteristics of one of erosive unconformability. Upon the second island, instead of a clear line of contact between the conglomerate and the Basement Complex, there is an apparent gradation, the change occurring within 5 or 6 feet. Here the solid granite gneiss is first broken: then in passing upward the angular fragments have moved somewhat; in passing still farther upward they become roundish and are mingled with extraneous material, until a bowlder conglomerate is reached which is in every respect like that before described.[1]"

This basal conglomerate is not of great thickness at any observed point in Bruce area and passes upward into 1,500 feet of white quartzite, portions of which carry thin conglomeratic beds of white and grey quartz pebbles. The quartzite is overlain by about 60 feet of conglomerate and above this is 150 feet of impure, siliceous limestone. The lower and upper portions of the limestone consist of alternating limestone and sandy layers from $\frac{1}{8}$ to 2 inches thick but the middle is less siliceous and the limestone layers are from 1 to 4 feet thick. In a few places the limestone is succeeded by a well stratified, schistose greywacke. The contacts of this greywacke with the formations below and above it are soil-concealed everywhere in this area, but in Whiskey Lake area what is regarded as the same greywacke was found to be conformably upon the same limestone. The greywacke is the highest member of the lower Huronian series found in Bruce area.

In lot 2, concession II of Aberdeen township, the limestone of the lower series, which dips 50 degrees southward, is overlain by a conglomerate carrying angular and rounded pieces of limestone and well rounded pebbles of granite, gneiss, etc. The contact is a slightly irregular one and the conglomerate rests upon the thick-bedded middle portion of the limestone formation, indicating that the upper, siliceous part had been eroded. At other places in the area this basal conglomerate of the upper series

[1] "The Pre-Cambrian Geology of North America": U.S.G.S. Bull. 360, pp. 414-415.

overlies the greywacke or the quartzite member of the lower series, so there is evidence of a considerable unconformity. Nevertheless, exact contacts are rarely visible and the very existence of the break in the succession is seldom appreciable.

The basal conglomerate of the upper series is from 50 to 125 feet thick and passes upward into 600-800 feet of white quartzite. This quartzite becomes dark and argillaceous at the top and in a thickness of 200 feet merges into what is usually called the upper slate conglomerate formation. In reality this is a complex alternation of greywacke, boulder conglomerate, quartzite, and finely laminated greywacke and greywacke-conglomerate. The succession as observed north of Rock lake is shown in Figure 3. On account of its distinctive lithological characters and great thickness (2,600-3,000 feet) this member is of more than ordinary importance for correlation of the successions in the various areas under discussion.

The upper slate conglomerate group terminates in a laminated greywacke, which grades imperceptibly in 200-300 feet into a dull red, impure quartzite, the base of the great upper quartzite formation. This quartzite, 5,500-6,000 feet thick, is dull red and impure at the base, but grades in about 1,000 feet into a white quartzite, which becomes still purer toward the top. About the middle of the formation the white quartzite carries conglomerate beds of small, well rounded pebbles of white and grey quartz and red jasper. Logan and Murray regarded these different phases of the quartzite as distinct formations, naming them the red quartzite, red jasper conglomerate, and white quartzite formations, but such a subdivision appears arbitrary and apt to obscure the fact that all three represent one continuous process of deposition.

The white quartzite passes gradationally upward into 700 feet of finely banded, chert-like quartzite, the individual beds of which are 12 inches or less thick and are coloured grey, buff, greenish, or white. This is the highest member of the upper series that occurs within Bruce area, but Logan and Murray record above it a white quartzite 1,500 feet thick, yellow chert and limestone 200 feet, and white quartzite 400 feet thick.

The diabase which intruded all the above-mentioned formations is probably of the same general age as the similar intrusives of Cobalt and Sudbury districts.

Blind River Area.

The great fault that crosses Bruce area is continuous across Blind River area also, lying parallel to and from half a mile to 2 miles north of Lake Huron. As in Bruce area the southern side is upthrown several thousand feet. The rocks brought together along this great plane of displacement are so unlike that they require more or less independent description.

South of the fault the granite-gneiss of Bruce area, or Killarney granite, is continuous eastward into this area. Here it contains ribbons and angular masses of black hornblende-gneiss, which probably represent inclusions of the igneous complex found at Thessalon. At Dean lake it also includes small bodies of finely crystalline hornblende-schist in which original bedding planes are still visible. In the eastern part of this area, east of Algoma, there is also a thick series of slate, quartzite, and conglomerate resembling the Sudbury series of Sudbury district, and these are intruded near Cutler station, by dykes of granite. Hence the crystalline complex south of the great fault in Blind River area comprises batholithic granite-gneiss intrusive into an older metamorphosed and closely folded sedimentary series. Quartzite and limestone like the Huronian of Bruce area also occur on the south side of the fault but always dipping from 50 degrees to 90 degrees, or even overturned, and in faulted relations to the granite and older sediments.

North of the fault the crystalline basement is represented by granite alone, and upon this granite younger sedimentary rocks rest in the same unconformable manner as they do in Bruce area. These sediments form a gentle monocline dipping southwestward toward the great fault, but this main structure is complicated by minor folds, and within 2 miles of the fault the beds are much more disturbed than are those in Bruce area. Frequently they are on edge or overturned, like those south of the

fault. On both sides of the fault, dykes and larger bodies of diabase like that of Bruce area invade these sediments and the crystalline basement.

The sediments overlying the crystalline basement are separated by an unconformity into lower and upper series as in Bruce area, and the succession in each is much the same as in that area. The basal member of the lower series is a feldspathic quartzite 1,500 feet, and possibly 2,000 feet thick. It rests immediately upon a surface of decayed granite. The unaltered granite beneath grades imperceptibly upward into 2 or 3 feet of decomposed, disintegrated granite, now recemented into a greenish granite devoid of dark minerals, and this, in its turn, into an arkose of much the same composition but in which rounded quartz and feldspar grains, and even an occasional small quartz pebble, are perceptible. A little higher up the arkose carries a few pebbles of quartz but there is no pronounced basal conglomerate like that found on the islets near Thessalon. The arkose changes in the first 100 feet into a more or less feldspathic white quartzite which varies but little in lithological character from there to the top; the only variations are some thin conglomerate beds carrying well-worn pebbles of white and grey quartz and about 150 feet of a dark grey, fine-grained quartzite.

Except in one place, this is the only member of the lower series that survived the subsequent Pre-Cambrian erosion. On the Lake Huron coast a mile west of Blind river a few feet of banded, siliceous limestone like that of Bruce area also remain. This vestige of limestone is overlain directly by 60 feet of conglomerate carrying numerous limestone pebbles. Both formations at this place are on edge and the line of contact is slightly at variance with the bedding planes in the limestone. At various points on Lauzon lake and Lake of the Mountains this basal conglomerate of the upper series overlies the lower quartzite. The contact line is slightly undulating. The conglomerate is 60–125 feet thick and consists usually of large, closely packed, rounded boulders, up to 2 feet in diameter, of granite, gneiss, greenstone, crystalline schists, conglomerate, greywacke, quartzite, and other rocks, but none of lime-

stone. In fact fragments of the lower series are nowhere abundant in it and are often angular or imperfectly rounded.

The basal conglomerate of the upper sedimentary series grades upward into 500–600 feet of white quartzite and this in turn into a slate conglomerate complex including the same association of deposits as in Bruce area, except that the order and relative thicknesses of these are notably different, as may be seen by comparing the columns in Figure 3. The lowermost member of the slate conglomerate is a massive boulder conglomerate consisting of boulders and pebbles of a great variety of rocks held together by a greywacke matrix of varying texture. This conglomerate is 600 feet thick and grades down into the underlying quartzite in a thickness of 20 feet. The Blind River section of the slate conglomerate also includes 40 feet of impure limestone interbedded with thin siliceous layers not found in Bruce area. The upper portion, near the great fault, is so crumpled and folded that no reliable measurement of its thickness could be obtained, but the entire complex is probably as thick as that found in Bruce area.

Whiskey Lake Area.

The most complete and least complicated sequence of formations obtained in this area occurs in township 144 and vicinity, being especially well exposed on the shores of Big lake. The country north of Big lake consists of granite and gneiss, and a few small areas of highly fissile slate intimately associated with the granite and apparently older than it. On Whiskey lake, 4 miles to the east, the granite is also intrusive into igneous greenstones and green schists. Hence the pre-Huronian complex comprises sedimentary rocks, an igneous schistose complex, and a younger batholithic granite intrusive. Two Huronian sedimentary series are exposed on Big lake, forming a gentle monocline that rests directly upon the granite-gneiss and dips from 15 degrees to 50 degrees southward. These sediments are intruded by dykes and larger bodies of diabase like that found in the areas already described.

At the bottom of the lower series is a feldspathic quartzite 1,000 feet thick, the base of which is a conglomerate, probably not over 75 feet thick, composed of granite, greenstone, and other boulders and pebbles, including a few of slate, enclosed in an arkose matrix. This conglomerate is usually separated from the underlying granite by from a few inches to several feet of arkose or disintegrated granite, which grades imperceptibly downward, in from 4 to 18 inches, into unaltered granite. Occasionally fissures filled with arkose can be traced downward into the granite. The conglomerate and arkose at the base of this lower quartzite clearly rest unconformably upon a decayed granite surface as in the Blind River and Bruce areas. The main upper part of the formation is a coarse-grained, feldspathic, white quartzite. Above this, in sharp and faintly unconformable contact, is 100–125 feet of conglomerate. The lower part consists of large boulders, principally of granite, embedded in arkose, but toward the top the matrix grows finer and more like a greywacke while the included fragments diminish in number and size. No good exposure was found showing the succession immediately above this second conglomerate but it is believed to grade upward into a greywacke only a few feet thick. This gives place conformably to 150 feet of grey limestone which carries thin siliceous layers in its upper and lower portions but is nearly pure in its main middle portion. The limestone passes conformably up into 350 feet of a dull grey, well stratified and somewhat calcareous greywacke, interbedded in places with more quartzitic beds. The greywacke is succeeded conformably by 50–75 feet of a very impure, red-weathering limestone in beds from 18 inches to several feet thick alternating with layers of siliceous greywacke 4 feet or more in thickness.

The red-weathering limestone and the underlying greywacke present several remarkable features that suggest the existence of subaërial conditions during their deposition. The greywacke includes, about 40 feet above its base, a breccia made up solely of fragments of that formation and of limestone. The greywacke and the upper limestone are also intersected by numerous clearly defined dykes or fissures 6–15 inches wide, filled with coarse, impure quartzite or fine conglomerate. These quartzite

dykes appear to be a widespread feature and suggest an equally widespread exposure of the formation which they intrude, to erosive agencies. Nevertheless, the limestone and greywacke are conformable with the adjacent formations and maintain a uniform thickness along their exposed edges for the entire 5 miles explored. There does not yet appear, therefore, to be convincing evidence of any important unconformity within these formations.

The upper limestone grades through 15 feet of greywacke and impure quartzite into a white, feldspathic quartzite 1,100 feet thick. At most places this is terminated by the unconformity between the lower and upper series, but at one point it grades up into 40 feet of interbedded quartzite and siliceous greywacke of dark grey colour before being interrupted by the unconformity.

The conglomerate and quartzite members of the upper series found beneath the slate conglomerate in Bruce and Blind River areas are lacking in this area: a boulder conglomerate exceeding 400 feet in thickness rests directly upon the greywacke and quartzite of the lower series. The lowermost 100–150 feet of this conglomerate, however, is really a well stratified formation consisting of thick-set beds of rounded pebbles alternating with beds of coarse quartzite. Above this it merges into a typical boulder conglomerate—pebbles and boulders, up to 6 feet in diameter, of a great variety of rock materials being scattered thickly and promiscuously through a dark grey grit or greywacke matrix rich in dark minerals. The evidences of unconformity between this conglomerate and the lower series are positive: the dip of the conglomerate beds differs as much as 15 degrees from that of the underlying quartzite; the conglomerate contains large fragments and rounded boulders of the underlying quartzite and greywacke; and the boundaries of the conglomerate lack the parallelism with the boundaries of the formations of the lower series that these lower formations show toward one another.

Espanola Area.

This area does not contribute anything to the Pre-Cambrian successions that is not already found in one or other of the areas

already described. It does, however, carry the succession found in these areas nearer to Sudbury district. There are two series of sediments resembling those in Whiskey Lake areas. The lower of these is composed, from the bottom upward, of quartzite, conglomerate, grey limestone, greywacke, impure red-weathering limestone and an upper quartzite formation and the upper series by a boulder conglomerate, which rests unconformably upon the lower series. These rocks are underlain by a greatly folded and extremely metamorphosed series of greywacke, slate, and quartzite, which is traceable fairly continuously into the Sudbury series of Sudbury district. The slate and greywacke are mostly recrystallized to mica-schist and hornblende-schist characterized by a vertical schistosity, and the quartzites also are more or less changed to sericitic schist or massive quartz-rock. The immediate contacts observed between these rocks and the younger sediments were all fault contacts, but at one point where they were exposed within 10 feet of each other the quartzite at the bottom of the lower of the two younger series is a peculiar arkose extremely rich in dark minerals which possibly originated from the underlying mica-schist of the Sudbury series by the same process of disintegration as that by which the basal arkose in Whiskey Lake and Blind River areas was derived from the granite beneath it. No granite occurs in Espanola area, but the highly metamorphosed sediments regarded as Sudbury series continue westward along the Canadian Pacific railway where they are intruded by granite.

Round Lake Area.

Crystalline and sedimentary rocks similar to the above are present in this area also, but do not afford a good geological section. The chief feature of interest is a well exposed intrusive contact of batholithic granite with a thick, feldspathic quartzite formation which is in continuity with the Copper Cliff arkose member of the Sudbury series in Sudbury district, and is almost certainly its equivalent.

Wanapitei Area.

For comparison of the successions found in the above-mentioned areas with those of Sudbury and Cobalt districts, the following summary is given of the sequence found near Lake Wanapitei, which is fairly representative of both these districts. A more complete account of this area may be found in the Summary Report of the Geological Survey, 1913. The pre-Huronian basement consists of an ancient complex of igneous schists and a probably younger, thick arkose formation (Copper Cliff formation of the Sudbury series), both of which are invaded by granite-gneiss. Upon a greatly eroded surface of these rocks lies a Huronian sedimentary series (Cobalt series). No measured section of the Cobalt series was obtained from this area, but, as indicated in Figure 3, there is a total thickness probably of 4,000 feet, consisting of a thick boulder conglomerate, greywacke, a thin band of siliceous limestone, greywacke, finely laminated greywacke sometimes conglomeratic, and a very thick feldspathic quartzite, all in conformable relations. The quartzite in other localities between Lake Wanapitei and Cobalt, contains a banded cherty quartzite like that found above the upper quartzite in Bruce area. The gaps left in the geological column in Figure 3, as in the other columns, represent uncertainty regarding thicknesses, not of the order and manner of succession. Sills and dykes of diabase invade both Huronian and pre-Huronian rocks.

CORRELATION OF AREAS.

Which formations in the areas just described are to be regarded as equivalents, and what is the importance of the erosional gaps, or unconformities, that interrupt the sequences? To make the answer to the first of these questions free from uncertainty the areas selected for comparison are so close together that there is little likelihood of the order of succession or the lithological characters of the formations changing sufficiently across any one interval to render correlation doubtful. Formations, especially distinctive ones like the limestones and

slate conglomerate, were, as a rule, easily recognizable in successive areas, although the independent use of this criterion has led in the past to the confusion of three different limestone formations which occur in or near the Original Huronian district. In most cases it was found possible to check the identity of lithologically similar formations in different areas by determining whether they were preceded or followed in each case by similar successions of other formations.

The areas studied were chosen mainly with a view to obtaining complete successions of the Huronian sediments and reliably correlating these. It was soon found that such areas were apt to be correspondingly poor in pre-Huronian sedimentary rocks and that an equally good correlation of the latter involved the selection and study of a second chain of areas containing good pre-Huronian successions. Consequently the following correlation is tentative and incomplete for the pre-Huronian sediments and the igneous rocks associated with them.

The principal subdivisions are considered in ascending order as follows:—

The Pre-Huronian.

The broad relationships existing between the pre-Huronian rocks in each of the areas under discussion, are summarized below:—

Bruce.	*Blind River.*	*Whiskey Lake.*
Granite-gneiss (Killarney)	Granite-gneiss (Killarney)	Granite-gneiss (Killarney ?)
Irruptive contact	Irruptive contact	Irruptive contact
Green schists	Metamorphic sediments.	Slate
		Green schists

Espanola.	*Round Lake.*	*Wanapitei.*
	Granite-gneiss	Granite-gneiss(same as at Round lake)
	Irruptive contact	Irruptive contact
Metamorphic sediments (Sudbury series ?)	Copper Cliff arkose (Sudbury series)	Copper Cliff arkose (Sudbury series)
		Green schists

Rock groups so diversified in appearance and mode of origin as the pre-Huronian batholithic granite-gneisses, sediments, and schistose volcanic complexes can be convincingly correlated only by tracing them as continuously as possible from place to place. This has been done, so far, in only a few instances. The Sudbury series (Copper Cliff arkose) is known to extend all the way from Wanapitei to Round Lake area. Sediments like those of the Sudbury series occur at many places along the Canadian Pacific railway between Espanola and Blind River, but until these have been more thoroughly studied, the pre-Huronian sedimentary formations in these two areas cannot be certainly identified with the Sudbury series.

The granite-gneiss intrusive into the Copper Cliff arkose at Wanapitei and Round Lake areas is part of the same batholithic mass. Also the granite-gneiss near Thessalon has been traced continuously into Blind River area and in all probability continues to Whiskey Lake area. But the relations of this Killarney granite, as it has been named, to the Wanapitei batholith remains undetermined.

The schist complex of Wanapitei area is pre-Sudbury in age, but the schists in Whiskey Lake and Bruce areas are only known to be pre-Killarney and may be either older or younger than the Sudbury series.

The Lower Huronian Series.

On the islets in Lake Huron just east of Thessalon and Bruce area, as already described, a white quartzite 1,500 feet thick and conglomeratic at its base, lies unconformably upon disintegrated Killarney granite-gneiss. It is the lowermost member of a conformable series consisting, above it, of about 60 feet of conglomerate, 150 feet of siliceous, banded limestone, and, in places, the eroded vestiges of a greywacke. In Blind River area, 10 miles to the east, a similar white quartzite 1,500-2,000 feet thick but only faintly conglomeratic at its base, rests in the same manner unconformably upon the same Killarney granite. There is also one erosion vestige of a siliceous banded limestone above the quartzite and the thin conglomerate which

intervenes between the quartzite and limestone in Bruce area is probably present also but concealed by the waters of Lake Huron. The lithological similarity and identical relations to the Killarney granite leave little doubt that the quartzite in Blind River area and the limestone above it are equivalents of the quartzite and limestone in Bruce area.

In Whiskey Lake area, 15 miles northeast of Blind River area, a white quartzite 1,000 feet thick and conglomeratic near its base also rests unconformably upon a surface of disintegrated granite, probably continuous with the granite at Blind River. It is the basal member of a conformable series composed in ascending order of conglomerate 125 feet, siliceous banded limestone 150 feet, greywacke 350 feet, impure red-weathering limestone 50-75 feet, white quartzite 1,100 feet, and erosion vestiges of an overlying siliceous greywacke. It is quite as evident here as in Blind River area that the first three formations correspond in practically all respects with the first three of Bruce area, in addition to which there are three other formations not represented in Bruce and Blind River areas.

In Espanola area there is no Killarney granite and no actual contact between the Huronian sediments and the older pre-Huronian sediments was seen; but a Huronian quartzite traced to within 10 feet of pre-Huronian slate was found to be discordant with the latter and composed of materials that suggested its derivation from disintegrated products of the underlying slate. This quartzite is conglomeratic just above its base and is hundreds of feet thick, like the lower quartzite in the preceding areas. Also it is succeeded conformably by conglomerate, siliceous limestone, greywacke, red weathering impure limestone, and a thick white quartzite as in Whiskey Lake area. Even such details as the quartzite and conglomerate dykes that cut the greywacke of Whiskey Lake area are repeated at Espanola. Upon these grounds this series at Espanola is regarded as equivalent to the lower sedimentary series of Whiskey Lake, Blind River, and Bruce areas.

Formations answering the same descriptions were observed in Round Lake area but have not been found in Wanapitei area, where the upper of the two Huronian series lies directly upon the pre-Huronian.

It is concluded from the above—also shown diagrammatically in Figure 3—that the pre-Huronian between the Original Huronian and Sudbury districts is unconformably overlain, upon a weathered and disintegrated surface, by a sedimentary series, the most complete observed section of which consists of:—

Siliceous greywacke.....	40	feet
White feldspathic quartzite (Serpent quartzite[1]).....	1,100	"
Red-weathering, impure limestone (Espanola limestone[1])	50–75	"
Stratified greywacke (Espanola greywacke[1])	350	"
Siliceous limestone (Bruce limestone[2]).....	150	"
Conglomerate(Bruce conglomerate[1])	50–125	"
Faint unconformity.....		
White feldspathic quartzite, arkosic or conglomeratic at base (Mississagi quartzite[2]).....	1,000-2,000	"
	2,740-3,840	feet

Attention was called in the description of Whiskey Lake area to a breccia and quartzite dykes in the greywacke and upper limestone formations and to a faint unconformity between the lower quartzite and the conglomerate above it. It is possible that unconformities of some size may be found at these horizons, but, so far as already observed, they appear to be inter- and intra-formational breaks of little chronological importance.

The Unconformity Between the Huronian and Pre-Huronian.

The Huronian sediments in the areas under discussion overlie granite-gneiss, metamorphosed sediments, and green schists—pre-Huronian rocks quite unlike them in appearance.

[1] New names.
[2] N. H. Winchell, Sixteenth Ann. Rep. Geol. and Nat. Hist. Survey of Minnesota, pp. 12-40; 145-171.

They do not often dip more than 45 degrees, while the pre-Huronian sediments beneath stand on edge or nearly so and the green schists have a similarly steep schistosity. Also the arkose found at the base of the Huronian in many places was derived from the pre-Huronian directly beneath, while the conglomerate which forms the basal member elsewhere contains pebbles and boulders of a great variety of pre-Huronian formations. It is evident, therefore, that the unconformity between the Huronian and pre-Huronian is a positive and strongly marked one.

When Logan and Murray worked in the country north of Lake Huron sixty years ago they were impressed by the unlikeness of what are here called the Huronian and pre-Huronian rocks. The former are little metamorphosed, and not greatly folded sediments, while the sediments and schists of the latter are closely folded, with more or less prominent secondary cleavage, are greatly metamorphosed, and are intruded by great batholithic masses of granite-gneiss. The significance of this difference between the Huronian and pre-Huronian and of the unconformity between them was expressed a year ago: "The Cobalt series rests upon a crystalline rock surface as maturely eroded and peneplain-like as the present surface of the region. The full chronological importance of the break is perhaps most apparent near Sudbury, where Cobalt conglomerate rests upon the upturned edges of the Sudbury series and upon the gneiss that intrudes the Sudbury series. In the interval between the deposition of the Sudbury series and the Cobalt series, the former was affected by orogenic movements, the granite batholiths were intruded, and the mountains so formed were reduced to a peneplain. Some conception of the time required for these changes may be gained from a consideration of the Rocky Mountain region, where seemingly analogous processes have been in progress since Jurassic time at least and are still far from complete."[1] The Cobalt series referred to in this extract is the same as the upper Huronian series of the present paper and the structural relations described for Sudbury are the same as those found north of Lake Huron.

[1] "A classification of the Pre-Cambrian formations in the region east of Lake Superior", page 406.

Some idea of the length of time represented by this break may also be gained by comparing the unconformity referred to in this quotation with that in, say, Whiskey Lake area. The structural relations of the over- and underlying formations are the same—gently folded Huronian sediments resting upon maturely eroded surfaces of closely folded sediments and schists, and invasive granite-gneiss—but in the case quoted the overlying sediments are the upper of the two Huronian series, while at Whiskey Lake they belong to the lower series. From a consideration of the structural features of the unconformity alone the time intervals represented in the two areas might be the same, yet the interval at Whiskey lake is actually less than that near Sudbury by the time required to lay down sedimentary materials 2,740 feet thick, In other words the whole time interval is so great that a portion of it requisite for the deposition of 2,740 feet of conglomerate, quartzite, greywacke, and limestone is too insignificant to find perceptible expression in the character of the unconformity.

The Upper Huronian Series.

The slate conglomerate group in Bruce area is composed largely of formations of peculiar appearance. It includes a boulder conglomerate which bears a distinct resemblance to a consolidated boulder clay and contains occasional striated boulders (Plate I). It includes also a laminated greywacke, or finely stratified argillitic formation consisting of layers of fine-grained, slate-grey greywacke one-fortieth to one-quarter inch thick that vary slightly in shade and give the rock a characteristic delicately laminated appearance. A conglomeratic phase of this laminated greywacke which carries occasional pebbles of granite, etc., up to 8 inches in diameter, is even more distinctive of the group. The only deposits of recent times comparable to the laminated greywacke and laminated greywacke conglomerate are the stratified boulder-containing clays laid down in post-Glacial lakes. The whole group is 2,600–3,000 feet thick and the individual formations in it vary notably in thickness and in order of succession in different parts of the area.

These rocks are quite unlike the rest of the Huronian, consequently the occurrence in another part of the country of a similar association, so peculiar in appearance and of such thickness, would in itself be strong evidence of their identity. Such an association of boulder conglomerate, laminated greywacke, laminated greywacke conglomerate and allied types, of the same order of thickness, does occur in Wanapitei area. In addition to this the slate conglomerate group in both areas is overlain conformably by a thick quartzite formation. This quartzite is characterized in each case by thin conglomeratic beds made up solely of small round pebbles of white and grey quartz in a quartzite matrix, the most conspicuous difference being the presence in Bruce area of bright red jasper pebbles that are lacking in the quartz conglomerate at Wanapitei. The banded cherty quartzite formation which overlies this quartzite in Bruce area is represented by a similar chert-like deposit in the upper portion of the quartzite of Wanapitei area. This similarity in composition and order of sequence of the slate conglomerate and upper quartzite of Bruce area to the Huronian succession in Wanapitei area is strengthened by another circumstance: the same assemblage of boulder conglomerate, laminated greywacke, etc., or a part of it, occurs in all the intervening areas. In Blind River area it is almost complete and contains in addition to all the types found in Bruce area, a thin siliceous limestone, which also occurs in Wanapitei area. In Whiskey Lake and Espanola areas, however, only the boulder conglomerate is present.

These grounds are regarded as sufficient for correlating the slate conglomerate group of Bruce, Blind River, and Wanapitei areas, and the boulder conglomerate of Whiskey Lake and Espanola areas. Likewise the upper quartzite and banded cherty quartzite of Bruce area are regarded as equivalent to the thick feldspathic quartzite (Lorrain quartzite) of Wanapitei area and the chert-like quartzite found associated with the Lorrain quartzite nearer to Gowganda.

Proceeding downward from the base of the slate conglomerate group toward the bottom of the upper Huronian series, the order is much less uniform in the various areas. In Wana-

pitei area the conglomerate is the basal member of the series and rests directly upon the pre-Huronian. Such is also the case in Espanola area, except that the conglomerate lies unconformably upon the lower Huronian series instead of the pre-Huronian. In Whiskey Lake area the boulder conglomerate is again unconformably upon the lower Huronian series, but while the main part is a typical unassorted and unstratified bouldery deposit like that at Wanapitei, the lowermost 100 or 150 feet is made up of well stratified, well assorted conglomerate beds alternating with beds of coarse quartzite, as if this portion had been laid down in water. At Blind River the boulder conglomerate is underlain conformably by 500 feet of white quartzite and 100–125 feet of coarse conglomerate before the unconformity between it and the lower Huronian series is reached. The quartzite and conglomerate resemble ordinary water-laid deposits, so that apparently in this locality 600 feet of gravel and sand now represented by these formations, were laid down in a lake or sea before the deposition of the slate conglomerate group began. In Bruce area the same conditions existed, and presumably for a longer time, for there is 600–800 feet of quartzite and 50–125 feet of conglomerate between the slate conglomerate and the bottom of the upper series.

The most complete succession of the upper Huronian series, that obtained in and near Bruce area, is as follows:—

White quartzite (of Logan)?	400	feet
Yellow chert and limestone (of Logan)?	200	"
White quartzite (of Logan)?	1500	"
Banded cherty quartzite	700	"
White quartzite, jasper conglomerate, and red quartzite (Lorrain quartzite[1])	5500—6000	"
Slate conglomerate group	2600—3000	"
White quartzite (Aberdeen quartzite[2])	600— 800	"
Basal conglomerate (Aberdeen conglomerate[2])	50— 125	"
	11550—12725	feet.

[1] W. G. Miller, Fourteenth Ann. Rep. Bureau of Mines, Ontario, part II.
[2] New names.

The Unconformity Between the Lower and Upper Huronian Series.

The relations of the upper to the lower Huronian series in Whiskey Lake area are well exemplified in a conspicuous bluff in the southwestern bay of Big lake. There the basal conglomerate of the upper series, dipping 15 degrees south, lies upon almost horizontal upper quartzite formation of the lower series. The actual contact along the face of the bluff is a sharply defined and somewhat wavy line cutting obliquely across the bedding planes of the quartzite. The conglomerate above contains a great variety of pebbles among which is a considerable number of quartzite and finely stratified greywacke evidently derived from the lower Huronian. While the granite and other pebbles foreign to the locality are well rounded and not large, some of those obtained from the sediments beneath are 2 feet in diameter and subangular.

There are numerous exposures on Lauzon lake and Lake of the Mountains in Blind River area, of the same unconformity between the basal conglomerate of the upper series and the lower quartzite (Mississagi) formation of the lower series. The conglomerate contains a similar diversity of materials and the fragments derived from the underlying formations of the lower series are often large and imperfectly worn. No pebbles of limestone could be found although on the coast of Lake Huron west of Blind River, where the conglomerate overlies the limestone, it contains numerous limestone pebbles. It seems probable that the fragments of the lower Huronian series were not as resistant to erosion as the older, and thoroughly consolidated pre-Huronian rocks, and hence only pebbles of one or a few of the lower Huronian formations are found in the conglomerate above. The contact is gently irregular, but beyond this there is no perceptible discordance in any one locality between the beds of the upper and lower series.

The same wavy, sharply defined line of contact, abundance of subangular to rounded pebbles of the underlying formation but dearth of other lower Huronian fragments, and lack of perceptible discordance characterizes the contact between the upper series conglomerate and the lower series limestone in lot 2,

concession II, Aberdeen township, in Bruce area, which has already been described.

Single outcrops showing this unconformity do not yield an adequate impression of its real importance. Little or no discordance between the two series is recognizable, almost all the pebbles representing the lower series in the basal conglomerate of the upper series are from the formation immediately subjacent, and these pebbles are often imperfectly worn. A comparison of the unconformity as it appears in various parts of each area and in the different areas, however, alters this impression. The plane of unconformity, diagrammatically indicated in Figure 3, cuts the Bruce limestone and Mississagi quartzite of the lower Huronian series in Bruce area, the Mississagi quartzite, Bruce limestone, and greywacke formations in Blind River area, and only the upper portion of the Serpent quartzite formation of the same series in Whiskey Lake area. Erosion, therefore, proceeded about 150 feet deeper in Blind River area than in Bruce area and about 1700 feet deeper than in Whiskey Lake area. Where the differences are so great the total erosion must have been considerably more.

Nevertheless, the period of erosion was not marked by any notable earth movements; for the lower series is folded little or no more than the upper series. Also the absence or scarcity in the basal conglomerate of the upper Huronian series, of pebbles representing the higher formations of the lower Huronian series, taken in conjunction with the abundance of pebbles of granite and other hard pre-Huronian rocks, seems to indicate that the lower Huronian rocks were not well enough consolidated and cemented to resist erosion.

These criteria place within approximate limits the duration of the erosion interval between the lower and upper Huronian series. It is certainly greatly inferior to that of the interval between the Huronian and the pre-Huronian.

CORRELATION OF DISTRICTS.

It has been shown that in Wanapitei area the upper of the two Huronian series consists of 4,000 feet of boulder conglomerate,

greywacke, limestone, and laminated greywacke (slate conglomerate group) and a thick, feldspathic quartzite. This succession, however, was shown in 1913 to be the same thing as the Cobalt series of Cobalt and adjoining districts. Also, the boulder conglomerate member is the Ramsay Lake conglomerate of Professor Coleman[1]. Upper Huronian and Cobalt are, therefore, just different names for a single series and Ramsay Lake conglomerate a name for one member of this series.

The equivalence of these names makes the series they designate a common plane of reference for the correlation of the Pre-Cambrian formation in the Original Huronian, Sudbury, and Cobalt districts. Column I in the accompanying table gives the succession for the Original Huronian district as represented by Bruce and Blind River areas. The names used are those given by Logan, Winchell, and others, supplemented by some new ones. Columns II and III, for Sudbury and Cobalt districts, are essentially the classifications of Coleman and Miller, respectively. Column IV is a composite of the other three, applicable to Timiskaming region.

Exception may, perhaps, be taken to the use in column IV of the names Cobalt series and Bruce series instead of Upper Huronian and Lower Huronian. The latter names are, indeed, preferable on the ground of priority, but they convey too precise significance for the present developmental state of Pre-Cambrian classification in Timiskaming region. There is no certainty that the upper of these two series forms the natural termination of the Huronian system, since the nature of its relations to younger sedimentary series in this region remains undetermined. So, why call it *Upper* Huronian? Moreover, the use of Upper Huronian and Lower Huronian might convey the incorrect impression that these series in Timiskaming region are correlated with series of the same name in the Lake Superior region. Accordingly, the only widely current equivalent for Upper Huronian, that is, Cobalt series, has been adopted. No such equivalent already exists for Lower Huronian so, rather than accept that compromising term, and for consistency in the use of local names, Bruce series is suggested as a substitute.

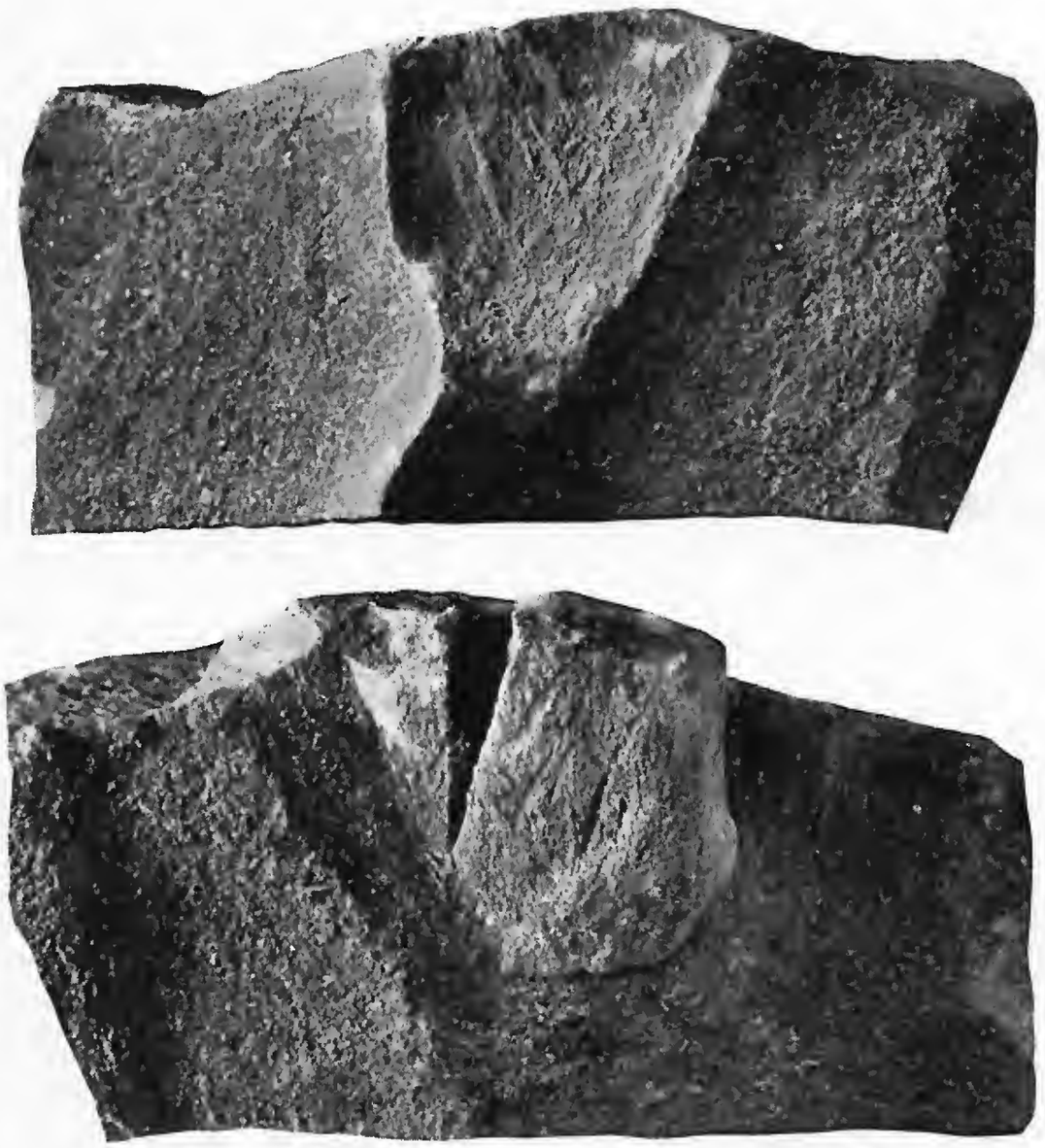
[1] The Nickel Industry: Publication No. 170, Mines Branch, Department of Mines, Canada, page 9.

The unconformity below the Bruce series represents the most important *known* Pre-Cambrian erosion interval in Timiskaming region. The formations above and below it are also distinctly unlike, in degree of diastrophic disturbance and metamorphism. Accordingly it is taken as the plane of separation of an upper, Huronian system from a residual older portion of the Pre-Cambrian which remains to be classified. To this imperfectly known part the temporary designation pre-Huronian is applied. The opportunity is taken to reiterate that the pre-Huronian is not regarded as co-ordinate with the Huronian, and that merely a dual division of the Pre-Cambrian is not intended. It is deemed entirely possible that the pre-Huronian may ultimately be subdivided into two or more parts each co-ordinate with the Huronian.

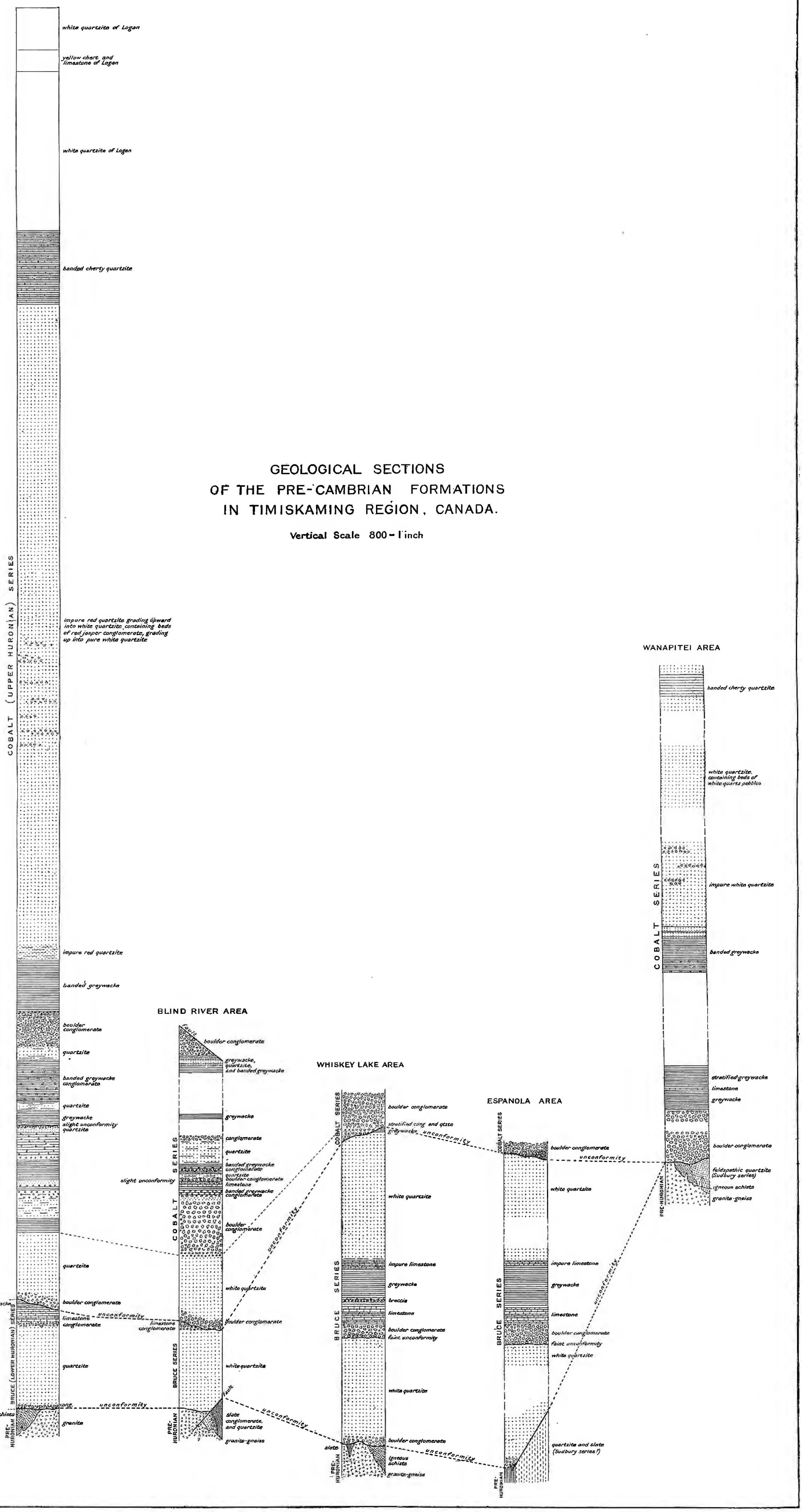
The upward extension of the Huronian in this region must remain somewhat in abeyance until the relations existing between the Cobalt and Whitewater series can be discovered. Only one area of Whitewater series rocks is known and this is so completely circumscribed and isolated from other sedimentary rocks by the Sudbury laccolith that, until another, more favourably situated area is discovered, the position of this series remains unproven.

Explanation of Plate I.

Striated pebble and cast of same from slate conglomerate, north of Rock lake, Bruce area. An impression of the striations may be seen on the cast.



I. Original Huronian	II. Sudbury	III. Cobalt	IV. Timiskaming region	
Pleistocene. Unconformity. Palæozoic.	Pleistocene.	Pleistocene. Silurian (Niagara).		
Unconformity.				
Olivine diabase dykes. Diabase sills and dykes.	Keweenawan: Latest granite dykes; Olivine-diabase dykes; Granite; Sudbury nickel-bearing eruptive.	Nipissing diabase.	Nipissing diabase, Sudbury norite, etc.	
			Intrusive contact.	
	Animikie: Chelmsford sandstone; Onwatin slate; Onaping tuff; Trout Lake conglomerate.		Whitewater series.	
Upper Huronian: White quartzite, and yellow chert and limestone (?); Banded cherty quartzite; Lorrain quartzite; Slate conglomerate; Aberdeen quartzite; " conglomerate.	Huronian: Ramsay Lake conglomerate.	Cobalt series (including Lorrain quartzite).	Cobalt series.	Huronian.
Unconformity.			Unconformity.	
Lower Huronian: Serpent conglomerate; Espanola limestone; " greywacke; Bruce limestone; Bruce conglomerate; Mississagi quartzite.			Bruce series.	
Great unconformity.		Unconformity and erosion.	Great unconformity.	
Killarney granite-gneiss.	Laurentian granitoid gneiss.	Lorrain granite.	Batholithic granite intrusives.	pre-Huronian
Intrusive contact.		Intrusive contact.	Intrusive contact.	
Quartzite, slate, and conglomerate.	Sudbury series: Acid and basic intrusives; Copper Cliff arkose; McKim greywacke.	Timiskaming series.	Sudbury series. Timiskaming series. Fabre series, etc.	
Thessalon schists.	Granite: Pebbles in Copper Cliff arkose.	Unconformity and erosion.	Unconformity.	
			Granite intrusives.	
	Lower Huronian (Keewatin).	Keewatin: Greenstone, porphyrite, etc.	Keewatin group.	



GEOLOGICAL SECTIONS
OF THE PRE-CAMBRIAN FORMATIONS
IN TIMISKAMING REGION, CANADA.

Vertical Scale 800 - 1 inch

Figure 3.

The first number of the Museum Bulletin was entitled, *Victoria Memorial Museum Bulletin, Number 1.*

The following articles of the Geological Series of Museum Bulletins have been issued.

Geological Series.

1. The Trenton crinoid, Ottawacrinus, W. R. Billings; by F. A. Bather.
2. Note on Merocrinus, Walcott; by F. A. Bather.
3. The occurrence of Helodont teeth at Roche Miette and vicinity, Alberta; by L. M. Lambe.
4. Notes on Cyclocystoides; by P. E. Raymond.
5. Notes on some new and old Trilobites in the Victoria Memorial Museum; by P. E. Raymond.
6. Description of some new Asaphidæ; by P. E. Raymond.
7. Two new species of Tetradium; by P. E. Raymond.
8. Revision of the species which have been referred to the genus Bathyurus (preliminary paper); by P. E. Raymond.
9. A new Brachiopod from the base of the Utica; by A. E. Wilson.
10. A new genus of dicotyledonous plant from the Tertiary of Kettle river, British Columbia; by W. J. Wilson.
11. A new species of Lepidostrobus; by W. J. Wilson.
12. Prehnite from Adams sound, Admiralty inlet, Baffin island, Franklin; by R. A. A. Johnston.
13. The origin of granite (micropegmatite) in the Purcell sills; by S. J. Schofield.
14. Columnar structure in limestone; by E. M. Kindle.
15. Supposed evidences of subsidence of the coast of New Brunswick within modern time; by J. W. Goldthwait.
16. The Pre-Cambrian (Beltian) rocks of southeastern British Columbia and their correlation; by S. J. Schofield.
17. Early Cambrian stratigraphy in the North American Cordillera, with discussion of the Albertella and related faunas; by L. D. Burling.
18. A preliminary study of the variations of the plications of Parastrophia hemiplicata, Hall; by A. E. Wilson.
19. The Anticosti Island faunas; by W. H. Twenhofel.
20. The Crowsnest Volcanics; by J. D. Mackenzie.
21. A Beatricea-like organism from the middle Ordovician; by P. E. Raymond.